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NATIONAL GUIDELINE CLEARINGHOUSE

General

Guideline Title

Operative fixation of rib fractures after blunt trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma.

Bibliographic Source(s)

Kasotakis G, Hasenboehler EA, Streib EW, Patel N, Patel MB, Alarcon L, Bosarge PL, Love J, Haut ER, Como JJ. Operative fixation of rib fractures after blunt trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2017 Mar;82(3):618-26. [41 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

NEATS Assessment

National Guideline Clearinghouse (NGC) has assessed this guideline's adherence to standards of trustworthiness, derived from the Institute of Medicine's report Clinical Practice Guidelines We Can Trust.

= Poor = Fair = Good = Very Good = Excellent

Assessment	Standard of Trustworthiness
YES	Disclosure of Guideline Funding Source
	Disclosure and Management of Financial Conflict of Interests
	Guideline Development Group Composition
YES	Multidisciplinary Group

UNKNOWN	Methodologist Involvement
▮▯▯▯▯	Patient and Public Perspectives
	Use of a Systematic Review of Evidence
▮▮▮▮▮	Search Strategy
▮▮▮▮▮	Study Selection
▮▮▮▮▯	Synthesis of Evidence
	Evidence Foundations for and Rating Strength of Recommendations
▮▮▮▮▮	Grading the Quality or Strength of Evidence
▮▮▮▯▯	Benefits and Harms of Recommendations
▮▮▮▮▮	Evidence Summary Supporting Recommendations
▮▮▮▮▮	Rating the Strength of Recommendations
▮▮▮▮▮	Specific and Unambiguous Articulation of Recommendations
▮▮▯▯▯	External Review
▮▯▯▯▯	Updating

Recommendations

Major Recommendations

The strength of recommendation (strong or weak/conditional) and levels of evidence (high, moderate, low or very low) are defined at the end of the "Major Recommendations" field.

Population, Intervention, Comparator, and Outcome (PICO) Question 1

In adult patients with flail chest after blunt trauma, should operative reduction and internal fixation of rib fractures (rib ORIF) be performed (versus non-operative management) to decrease mortality; duration of mechanical ventilation (DMV), intensive care unit (ICU) length of stay (LOS), and hospital LOS; incidence of pneumonia and need for tracheostomy; and improve pain control (O)?

Recommendation

In adult patients with flail chest after blunt trauma, the guideline authors conditionally recommend rib ORIF to decrease mortality; shorten duration of mechanical ventilation, ICU LOS and hospital LOS; incidence of pneumonia and need for tracheostomy. The guideline authors cannot offer a recommendation for pain control with currently available evidence.

PICO Question 2

In adult patients with non-flail rib fractures after blunt trauma, should rib ORIF be performed (versus non-operative management) to decrease mortality and incidence of pneumonia; shorten DMV, hospital LOS;

improve pain control; and decrease need for tracheostomy if applicable?

Recommendation

In adult patients with non-flail rib fractures after blunt trauma, the guideline authors cannot offer a recommendation for any of the outcomes with currently available evidence.

Definitions

Grading of Recommendations Assessment, Development and Evaluation (GRADE) Methodology Levels for Rating the Quality of Evidence

Quality Level	Definitions
High	Very confident that the true effect lies close to estimate of effect
Moderate	Moderate effect; true effect is likely close to estimate of effect but may be substantially different
Low	Limited confidence; true effect may be substantially different from estimate of effect
Very Low	Little confidence; true effect likely substantially different from estimate of effect

GRADE Definition of Strong and Weak Recommendation

	Strong Recommendation	Weak/Conditional Recommendation
For patients	Most patients would want the recommended course of action.	Most patients would want the recommended course of action, but many would not.
For clinicians	Most patients should receive the recommended course of action.	Different choices will exist for different patients, and clinicians should help patients decide.
For policy makers	Recommended course should be adopted as policy.	Considerable debate and stakeholder involvement needed to make policy.

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Rib fracture (flail and non-flail chest patterns) following blunt trauma

Guideline Category

Management

Clinical Specialty

Critical Care

Emergency Medicine

Thoracic Surgery

Intended Users

Physicians

Guideline Objective(s)

To perform a systematic review and to develop evidence-based recommendations regarding which patients with blunt chest wall trauma should undergo operative reduction and internal fixation (rib ORIF), following the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) methodology

Target Population

Adult patients (>18 years of age) with rib fractures (with and without flail chest) following blunt trauma

Interventions and Practices Considered

Operative fixation and internal reduction of rib fractures (versus non-operative management)

Major Outcomes Considered

- Mortality
- Duration of mechanical ventilation (DMV)
- Intensive care unit (ICU) length of stay (LOS)
- Hospital LOS
- Incidence of pneumonia
- Need for tracheostomy
- Pain control

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Identification of References

The systematic review was registered with the PROSPERO registry of systematic reviews and meta-analyses (Registration No. CRD42014015575). Subsequently, PubMed, EMBASE, and the Cochrane databases were searched in duplicate by professional librarians from two medical schools (Boston University and Harvard University) on January 29, 2016. The following medical subject headings (MeSH) terms were included: *rib fracture, flail chest, fracture treatment, surgical management, fixation, plating, operative reduction and internal fixation (ORIF)* in various combinations (see the full strategy in the original guideline document). No restrictions were placed on language. The ranges for their literature search were from January 1900 to January 2016. Prospective trials and retrospective cohort/case-control

studies that compared rib ORIF versus non-operative management of rib fractures in adults with either flail and/or non-flail chest patients were eligible for inclusion and were retrieved. Case reports, commentaries, and animal studies were excluded, as were studies describing operative technique alone, and reviews. The reference lists of retrieved papers were also screened to identify additional studies. For a study to be included in their final analysis, a clear comparison between operative versus non-operative subjects had to be present and at least one of the critical outcomes reported.

Upon completion of the electronic literature search, citation lists were independently reviewed by two authors to identify potentially relevant studies. Titles and abstracts were screened, and full articles were reviewed as needed. Any disagreement on inclusion was resolved by consensus (see Figure 1 in the original guideline document).

Number of Source Documents

22 articles were included in the quantitative and qualitative synthesis.

Refer to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Figure 1) in the original guideline document.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Grading of Recommendations Assessment, Development and Evaluation (GRADE) Methodology Levels for Rating the Quality of Evidence

Quality Level	Definitions
High	Very confident that the true effect lies close to estimate of effect.
Moderate	Moderate effect; true effect is likely close to estimate of effect but may be substantially different.
Low	Limited confidence; true effect may be substantially different from estimate of effect.
Very Low	Little confidence; true effect likely substantially different from estimate of effect.

Methods Used to Analyze the Evidence

Meta-Analysis

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Outcome Measures

Numerous candidate outcomes (including in-hospital mortality; duration of mechanical ventilation (DMV), intensive care unit (ICU) length of stay (LOS), and hospital LOS; incidence of pneumonia; need for tracheostomy; pain control; lung volumes on spirometry; quality of life after discharge; exercise tolerance; chronic disability; and time away from work) were voted on independently by each author on a

scale from 1 to 9 per the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology. Outcomes with scores 7 to 9 were considered critical, those with scores 4 to 6 were considered important, and those with scores in the 1 to 3 range were considered of limited importance. After rounding to the nearest integer, outcomes with an average score of 7 or greater (considered to be critical) were included in the population, intervention, comparison, and outcome (PICO) questions. The intervention, operative reduction and internal fixation of rib fractures (rib ORIF), was compared against non-operative management, as described earlier. Finally, patients were grouped into those with flail chest as defined by each reviewed manuscript although classically defined as those with three or more consecutive ribs fractured at 2 or more sites each, and those without flail chest pattern. The rounded average scores for each of the considered clinically relevant outcomes are summarized in Table 1 in the original guideline document.

Data Extraction and Methodology

Data extraction from each study was performed using standardized data collection sheets and was performed in duplicate. Data extracted included authors; journal; publication year; country of origin; study design; whether patients with traumatic brain injury were excluded; patients' age, gender, and Injury Severity Scores; number of patients in the operative and non-operative arms; number of patients with flail and non-flail chest rib fracture patterns (if available); time from admission to operation (if available), and the critical outcomes previously outlined (including mean and standard deviation [SD] values for the continuous outcomes). Whenever only mean and *p* values were provided and no SDs for the continuous variables, the latter were calculated using the following formula: Standard Deviation (SD) = [(Mean Difference/*t*-Score)]/Square Root of (1/N1 + 1 N2), where the *t*-score was calculated for each outcome using the provided *p* value and each study's degrees of freedom. N1 and N2 represent the number of patients in the ORIF and non-operative groups, respectively. If no *p* value was provided but statistical significance was declared, the highest *p* value of the alpha error declared by the authors was used for the SD calculations (e.g., if statistical significance was declared at a two-tailed level of less than 0.05 and no exact *p* value was provided, it was assumed that the *p* value was 0.05). When a range was provided and no SD, the latter was calculated by subtracting the minimum from the maximum value and dividing by 4. Forest plots were generated and treatment effects calculated, with each study weighing proportionally to the number of subjects it contributed in each outcome analysis. Heterogeneity for the analysis of each outcome was calculated using χ2 (Cochran Q statistic) and quantified with I^2. I^2 values less than 25% were considered to provide a low degree of heterogeneity; I^2 values in the 25% to 50% range moderately heterogeneous, and values greater than 50% were indicative of high heterogeneity.

Publication bias was evaluated using the Egger test, and the GRADE framework was applied to all quantified outcomes for assessment of bias, publication bias, inconsistency, imprecision, and indirectness. Analyses were performed with STATA, version 13.1 (Stata, College Station, TX), and all recommendations and their reported strengths were reviewed and agreed on by the entire authoring team. GRADEpro GDT (Cochrane Informatics & Knowledge Management, Baltimore, MD) was used to generate evidence profile tables.

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

The population, intervention, comparator, and outcome (PICO) questions are defined as follows:

Population: adult patients (>18 years of age) with rib fractures following blunt trauma.
Intervention: operative fixation of fractured ribs.
Comparator: non-operative management.
Outcomes: mortality; duration of mechanical ventilation (DMV); intensive care unit (ICU) and hospital length of stay (LOS); incidence of pneumonia; need for tracheostomy; and pain control.

PICO Question 1: In adult patients with flail chest after blunt trauma, should operative reduction and internal fixation of rib fractures (rib ORIF) be performed (versus non-operative management) to decrease mortality; DMV, ICU LOS, and hospital LOS; incidence of pneumonia and need for tracheostomy; and improve pain control?
PICO Question 2: In adult patients with non-flail rib fractures after blunt trauma, should rib ORIF be performed (versus non-operative management) to decrease mortality and incidence of pneumonia; shorten DMV, hospital LOS; improve pain control; and decrease need for tracheostomy if applicable?

Rating Scheme for the Strength of the Recommendations

Grading of Recommendations Assessment, Development and Evaluation (GRADE) Definition of Strong and Weak Recommendation

	Strong Recommendation	Weak/Conditional Recommendation
For patients	Most patients would want the recommended course of action.	Most patients would want the recommended course of action, but many would not.
For clinicians	Most patients should receive the recommended course of action.	Different choices will exist for different patients, and clinicians should help patients decide.
For policy makers	Recommended course should be adopted as policy.	Considerable debate and stakeholder involvement needed to make policy.

Cost Analysis

One research group (n = 37; 18 patients underwent rib operative reduction and internal fixation [ORIF] and 19 non-operative management) conducted the first prospective randomized clinical trial including adult blunt trauma victims with severe flail chest on mechanical ventilation, unable to wean by post-injury Day 5. Patients with fewer than six fractured ribs; those with severe closed head injury (head Abbreviated Injury Scale [AIS] >3) and/or spinal injury; with chronic preexisting heart, pulmonary, hepatic, and/or renal disease were excluded. Rib fixation afforded shorter duration of mechanical ventilation (DMV) and intensive care unit (ICU) length of stay (LOS), lower incidence of pneumonia and need for tracheostomy, and improved pain and subjective shortness of breath, all while hastening functional recovery. This study also demonstrated that these outcomes could be achieved with lower costs.

Another research group randomized 46 flail chest victims, if they were ventilator dependent with no prospect of successful weaning within the next 48 hours. Subjects older than 80 years, severe traumatic brain injury (Glasgow Coma Scale <10), spinal injuries precluding lateral decubitus positioning, and open rib fractures with soiling or infection were excluded. Patients undergoing rib fixation (n = 23) benefitted from shorter DMV and ICU LOS, as well as decreased need for postoperative non-invasive ventilation. These outcomes also accompanied significant cost savings, although no differences were noted in quality of life, spirometric findings, or activity levels at later follow-ups.

Method of Guideline Validation

Not stated

Description of Method of Guideline Validation

Not applicable

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- In one study, rib fixation afforded shorter duration of mechanical ventilation (DMV) and intensive care unit (ICU) length of stay (LOS), lower incidence of pneumonia and need for tracheostomy, and improved pain and subjective shortness of breath, all while hastening functional recovery. In another study, the group demonstrated reduced DMV, ICU LOS and hospital LOS, as well as lower incidence of pneumonia and chest wall deformity. Spirometry was also noted to be improved 2 months after injury. In a third study, patients undergoing rib fixation (n = 23) benefitted from shorter DMV and ICU LOS, as well as decreased need for postoperative noninvasive ventilation. These outcomes also accompanied significant cost savings, although no differences were noted in quality of life, spirometric findings, or activity levels at later follow-ups.
- Regarding the optimal timing of operative reduction and internal fixation (rib ORIF), it seems that patients enrolled in studies that offered surgery early (within 24–72 hours after injury) enjoyed shorter DMV, ICU LOS, and hospital LOS, as well as lower incidence of pneumonia and need for tracheostomy, compared to those that were operated on later on (72 hours after injury).
- Although significant selection bias may exist, one study showed that patients who underwent rib ORIF had improved pain scores postoperatively and were able to return to baseline activity earlier. In another study, patients self-selected operative or conservative management. Those who underwent surgery had shorter DMV, ICU LOS, and hospital LOS; and their incidence of pulmonary infections, mortality, and need for tracheostomy was lower compared to their on operative counterparts. Pain control was also improved in the rib ORIF group.

Refer to the "Qualitative Synthesis" and "Quantitative Synthesis (Meta-analysis)" sections of the original guideline document for discussions of the evidence related to benefits of specific interventions.

Potential Harms

Brain injury is associated with higher mortality rates, and afflicted subjects may not derive the full benefit of operative reduction and internal fixation of rib fractures (rib ORIF) owing to extrapulmonary reasons. Conversely, severe brain trauma victims may not be able to lie flat for lengthy chest operations in the presence of intracranial hypertension, and the risk-to-benefit ratio of chest wall reconstruction has to be carefully evaluated on an individual basis.

Refer to the "Qualitative Synthesis" and "Quantitative Synthesis (Meta-analysis)" sections of the original guideline document for discussions of evidence related to harms of specific interventions.

Qualifying Statements

Qualifying Statements

- The Eastern Association for the Surgery of Trauma (EAST) is a multi-disciplinary professional society committed to improving the care of injured patients. The Ad Hoc Committee for Practice Management Guideline Development of EAST develops and disseminates evidence-based information to increase the scientific knowledge needed to enhance patient and clinical decision-making, improve health care quality, and promote efficiency in the organization of public and private systems of health care delivery. Unless specifically stated otherwise, the opinions expressed and statements made in this publication reflect the authors' personal observations and do not imply endorsement by nor official policy of EAST.
- "Clinical practice guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances."* These guidelines are not fixed protocols that must be followed, but are intended for health care professionals and providers to consider. While they identify and describe generally recommended courses of intervention, they are not presented as a substitute for the advice of a physician or other knowledgeable health care professional or provider. Individual patients may require different treatments from those specified in a given guideline. Guidelines are not entirely inclusive or exclusive of all methods of reasonable care that can obtain/produce the same results. While guidelines can be written that take into account variations in clinical settings, resources, or common patient characteristics, they cannot address the unique needs of each patient nor the combination of resources available to a particular community or health care professional or provider. Deviations from clinical practice guidelines may be justified by individual circumstances. Thus, guidelines must be applied based on individual patient needs using professional judgment.

*Institute of Medicine. Clinical practice guidelines: directions for a new program. MJ Field and KN Lohr (eds) Washington, DC: National Academy Press. 1990: pg 39.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Kasotakis G, Hasenboehler EA, Streib EW, Patel N, Patel MB, Alarcon L, Bosarge PL, Love J, Haut ER, Como JJ. Operative fixation of rib fractures after blunt trauma: a practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2017 Mar;82(3):618-26.

[41 references] PubMed

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2017 Mar

Guideline Developer(s)

Eastern Association for the Surgery of Trauma - Professional Association

Source(s) of Funding

Eastern Association for the Surgery of Trauma (EAST)

Guideline Committee

Not stated

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

GK is the recipient of the NIH-NIGMS grant "Targeted polymerized shell microbubbles to image surgical adhesions" (R41GM116530) as coinvestigator and NIH-NCATS grant "Predicting and Preventing Re-Admissions Within 30 days after Surgery" (1UL1TR001430-01) as co-primary investigator. He is also the recipient of Boston University's Faculty Research Scholarship fund "Histone Acetylation in Acute Lung Injury" as primary investigator and receives royalties for developing surgical training modules from

McGraw-Hill Medical. He is also the paid author of a textbook chapter commissioned by Wolters- Kluwer Health for "Greenfield's Surgery: Scientific Principles and Practice, 6th Edition" entitled "Surgical Nutrition," and the paid author of a textbook chapter commissioned by Elsevier for "Advances in Surgery, 2015 Edition" entitled "Trainee Participation in Emergency Surgery: What Are the Consequences?" EAH is a paid consultant for DePuy Synthes Trauma. He receives research grants support as well as a grant for a research fellow from DePuy Synthes Trauma. He is also a paid lecturer and faculty for AO North America Trauma. MBP is supported by the Vanderbilt Faculty Research Scholars Program and NIH (HL111111). EH is the primary investigator of a grant (1R01HS024547-01) from the Agency for Healthcare Research and Quality (AHRQ) titled "Individualized Performance Feedback on Venous Thromboembolism Prevention Practice" and a contract (CE-12-11-4489) with The Patient-Centered Outcomes Research Institute (PCORI) titled "Preventing Venous Thromboembolism: Empowering Patients and Enabling Patient-Centered Care via Health Information Technology." He receives royalties from Lippincott Williams & Wilkins for the book *Avoiding Common ICU Errors* and is a paid consultant and speaker for the "Preventing Avoidable Venous Thromboembolism—Every Patient, Every Time" VHA/Vizient IMPERATIV® Advantage Performance Improvement Collaborative and the Illinois Surgical Quality Improvement Collaborative "ISQIC." He was the paid author of a paper commissioned by the National Academies of Medicine titled "Military Trauma Care's Learning Health System: The Importance of Data Driven Decision Making," which was used to support the report titled "A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury."

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the Journal of Trauma and Acute Care Surgery Web site .

Availability of Companion Documents

The following is available:

> Kerwin AJ, Haut ER, Burns JB, Como JJ, Haider A, Stassen N, Dahm P, Eastern Association for the Surgery of Trauma Practice Management Guidelines Ad Hoc Committee. The Eastern Association of the Surgery of Trauma approach to practice management guideline development using Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology. J Trauma Acute Care Surg. 2012 Nov;73(5 Suppl 4):S283-7. Available from the Eastern Association for the Surgery of Trauma (EAST) Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on May 9, 2017. The information was verified by the guideline developer on May 18, 2017.

This NEATS assessment was completed by ECRI Institute on June 22, 2017. The information was verified by the guideline developer on July 26, 2017.

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